

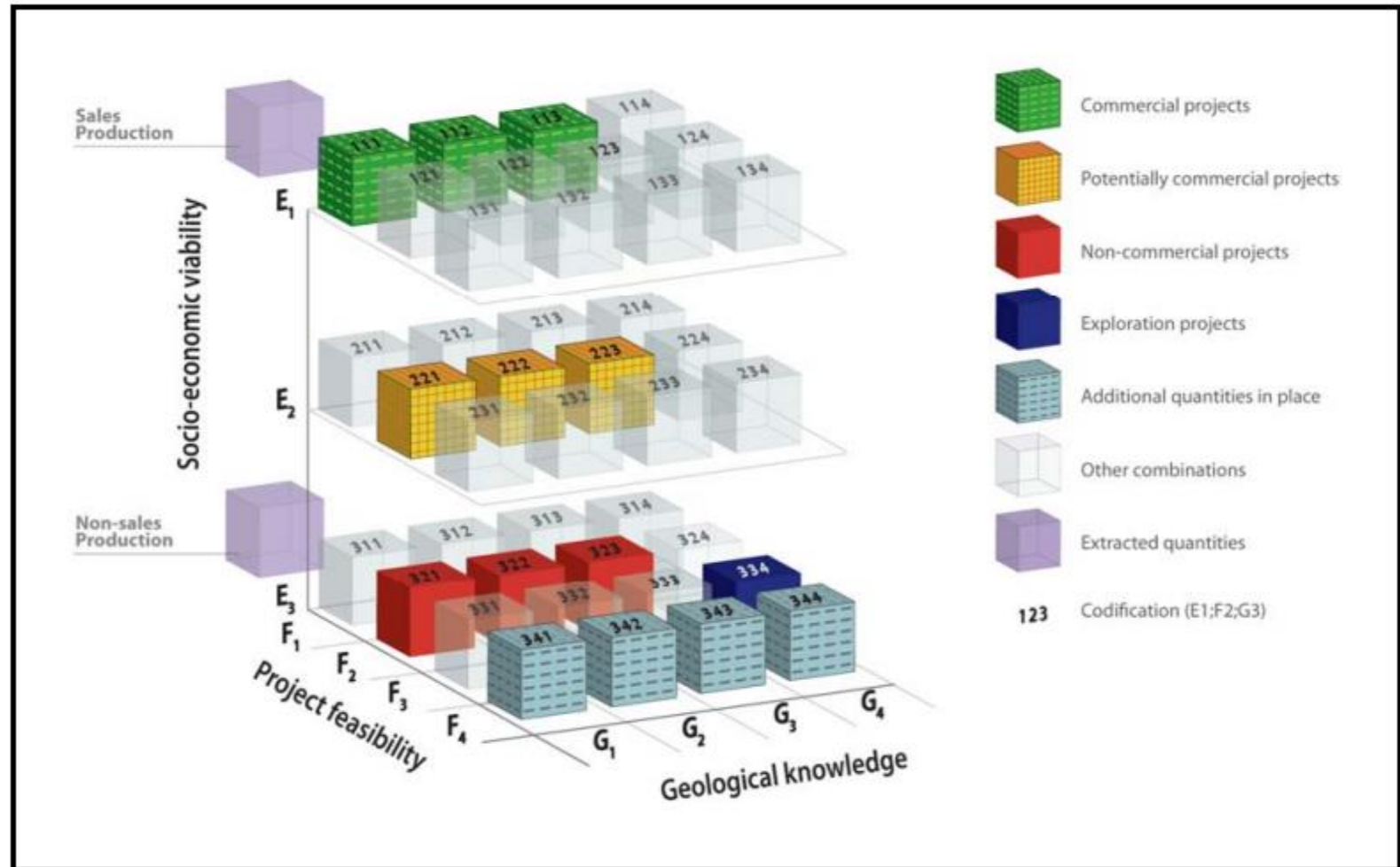


CASE STUDY ON THE APPLICATION OF THE UNFC TO ENERGY AND MINERAL RESOURCES IN KAZAKHSTAN

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United nations framework classification for fossil energy and mineral reserves and resources 2009

UNFC-2009 categories and examples of classes



Application of the system

UNFC-2009 applies to fossil energy and mineral reserves and resources located surface and subsoil. It is designed to meet as much as possible the needs associated with research on energy and minerals, resource management, corporate business processes and financial reporting standards.

Categories and subcategories

UNFC-2009 is an universal system where quantities are classified based on three main criteria:

- I. economic and social viability of the project (E)
- II. field development status and feasibility (F)
- III. geological knowledge (G).

Axis E - determines the degree of favorable social and economic conditions to ensure the commercial viability of the project, which include market prices and relevant legal, regulatory, environmental and contractual conditions.

Axis F - determines the degree to which studies are developed and the commitments made are necessary to implement mining plans or field development projects. They cover the area from early exploration work carried out before confirming the presence of a deposit or deposits, and to the project, in accordance with which the extraction and sale of raw materials takes place; they reflect standard supply chain management principles.

G axis - determines the level of reliability of geological knowledge and potential recoverability of the quantities.

System Classes

The class is uniquely determined by selecting in each of the three criteria for a particular combination of categories or subcategories (or group of categories/subcategories).

Considering that, code numbers always follow in the same order (i.e. E; F; G), letters can be omitted and only numbers could be stored. Determinative class code number will be the same in all languages which used Arabic numerals that is system unification.

Abbreviated version of UNFC-2009 system

Abbreviated version of UNFC-2009, showing primary classes

Total Commodity Initially in Place	Extracted	Sales Production			
		Non-Sales Production ^a			
		Class	Categories		
			E	F	G ^b
	Future recovery by commercial development projects or mining operations	Commercial Projects ^c	1	1	1, 2, 3
	Potential future recovery by contingent development projects or mining operations	Potentially Commercial Projects ^d	2 ^e	2	1, 2, 3
		Non-Commercial Projects ^f	3	2	1, 2, 3
	Additional quantities in place associated with known deposits ^g		3	4	1, 2, 3
	Potential future recovery by successful exploration activities	Exploration Projects	3	3	4
	Additional quantities in place associated with potential deposits ^g		3	4	4

Classes and subclasses of the UNFC-2009 system.

UNFC-2009 classes and sub-classes defined by sub-categories

UNFC Classes Defined by Categories and Sub-categories						
Total Commodity Initially in Place	Extracted	Sales Production				
		Non-sales Production				
	Class		Sub-class	Categories		
				E	F	G
	Known Deposit	Commercial Projects	On Production	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Projects	Development Pending	2 ^b	2.1	1, 2, 3
			Development On Hold	2	2.2	1, 2, 3
		Non-Commercial Projects	Development Unclassified	3.2	2.2	1, 2, 3
			Development Not Viable	3.3	2.3	1, 2, 3
		Additional Quantities in Place		3.3	4	1, 2, 3
	Potential Deposit	Exploration Projects	[No sub-classes defined] ^c	3.2	3	4
		Additional Quantities in Place		3.3	4	4

Reserves and resources classification system definition of the RK

Phased study of mineral resources based on project management

Forecast reserves

D0, D1, D2

**Prospective
regional**

Area justification
for planning of exploration
activities resources

Prospective reserves

C3

Exploration stage

Justification of exploratory
drilling and discovery
oil and gas reservoirs

**Proven and pre-
estimated reserves**

C1, C2

Trial Period

Definition industrial
significance of the field

**Proved developed
reserves**

A, B, C1

Field Development

Commercial production
and fulfillment of field
development obligations

Additionally entered reserves categories for UNFC comparison

Reserves (A*, B*, C1*; A**, B**, C1**)

Technically recoverable, but unprofitable for extraction. Under current economic conditions, hydrocarbon reserves of categories A, B, C1 are designated as A*, B*, C1*. Reserves marked "*" are defined as part of technically recoverable reserves that are not commercially viable at present. It is calculated by subtracting profitable recoverable reserves from technically recoverable reserves. Technically recoverable and profitable recoverable reserves defined in each development project.

Technically non-recoverable reserves are specified as A**, B**, C1**, C2**. In the UNFC classification, they are classified as "Additional quantities in place". In the RK Classification, doesn't exist "Additional quantities in place" there are geological reserves and technically recoverable reserves. Reserves of any category with a "***" sign are the result of subtracting technically recoverable reserves from geological reserves of the same category.

Recoverable reserves. Oil, gas, condensate and associated valuable components for reservoirs (fields) under development (A, B1, B2) recoverable reserves determined by technical and economic calculations for the recommended development option approved in accordance with the established procedure, in accordance with the IF, CIG, CGI. And calculated in the field development project for the cost-effective period of development and for the period of full development of reserves.

Exploration fields refers to (C1 and C2). Oil, gas and condensate field recoverable reserves estimation carried out in the Trial Operation Project approved in accordance with the established procedure, and in accordance with expert estimates or simplified statistical methods of determining the coefficients of extraction (empirical methods, quantum method, method of analogy).

RK and UNFC Classification Comparison by the degree of geologic knowledge (G axis)

In the RK Classification, an unprofitable part of the reserves of the deposit is allocated. Reserves with the “*” symbol: A *, B *, C1 * and reserves with the “***” symbol belong to the same categories along the G axis as reserves without the signs “*” and “***”. Those. the geological reliability of non-recoverable reserves is the same as the reliability of recoverable reserves in any category.

The same logic applies to technically non-recoverable reserves A **, B **, C1 ** and C2 **.

While the UNFC provides the opportunity to refine the G4 category to account for uncertainties for additional quantities, the RK classification does not provide for an uncertainty range. G4 when used without division into subcategories represents the best rating.

	UNFC Categories	RK Categories
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	A, B, C1, A*, B*, C1*, A**, B**, C1**
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	C1, C2 (50 to 50 % ratio)
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	C1 < 50%, C2 > 50%
G4	Estimated quantities associated with a potential deposit, based primarily on indirect evidence.	C3, D0

Comparison of classes and categories of the Classification of the Republic of
Kazakhstan and
UNFC along the axes E (socio-economic maturity), F (stage of technical
implementation) and G (geological exploration).

	RK Categories Classification	UNFC Categories			UNFC Classes
Known Deposit	A,B,C1	E1	F1	G1,G2,G3	Commercial Projects
	C1, C2	E2	F2	G1,G2,G3	Potentially Commercial
	C1, C2	E3	F2	G1,G2,G3	Non-Commercial Projects
	A**,B**,C1**,C2**(no n-recoverable)	E3	F4	G1,G2,G3	Additional Quantities in Place
Potential Deposit	C3,D0,D1,D2	E3	F3	G4	Exploration Projects
	C3,D0,D1,D2 (non- recoverable)	E3	F4	G4	Additional Quantities in Place

Comparison of the matrix in the E-F axes with the classes and categories of the RK Classification

Class	Sub-class	Code	RK Categories
Commercial Projects	On Production	1	A,B,C1
	Approved for Development	2	B,C1
	Justified for Development	3	C1(80%), C2(20%)
Potentially Commercial Projects	Development Pending	4	C1(50%), C2(50%)
	Development On Hold	5	C1 < 50%, C2 > 50%
Non-Commercial Projects	Development Unclassified	6	C1, C2
	Development Not Viable	7	C1, C2
Additional Quantities in Place		11	A**, B**, C1**, C2**
	Ready to open promising object	8	C3
	Probable exploration object	9	D0
	Possible exploration object	10	D1, D2
Additional Quantities in Place		11	C3, D0, D1, D2
forecasted to be extracted but not sold		12	

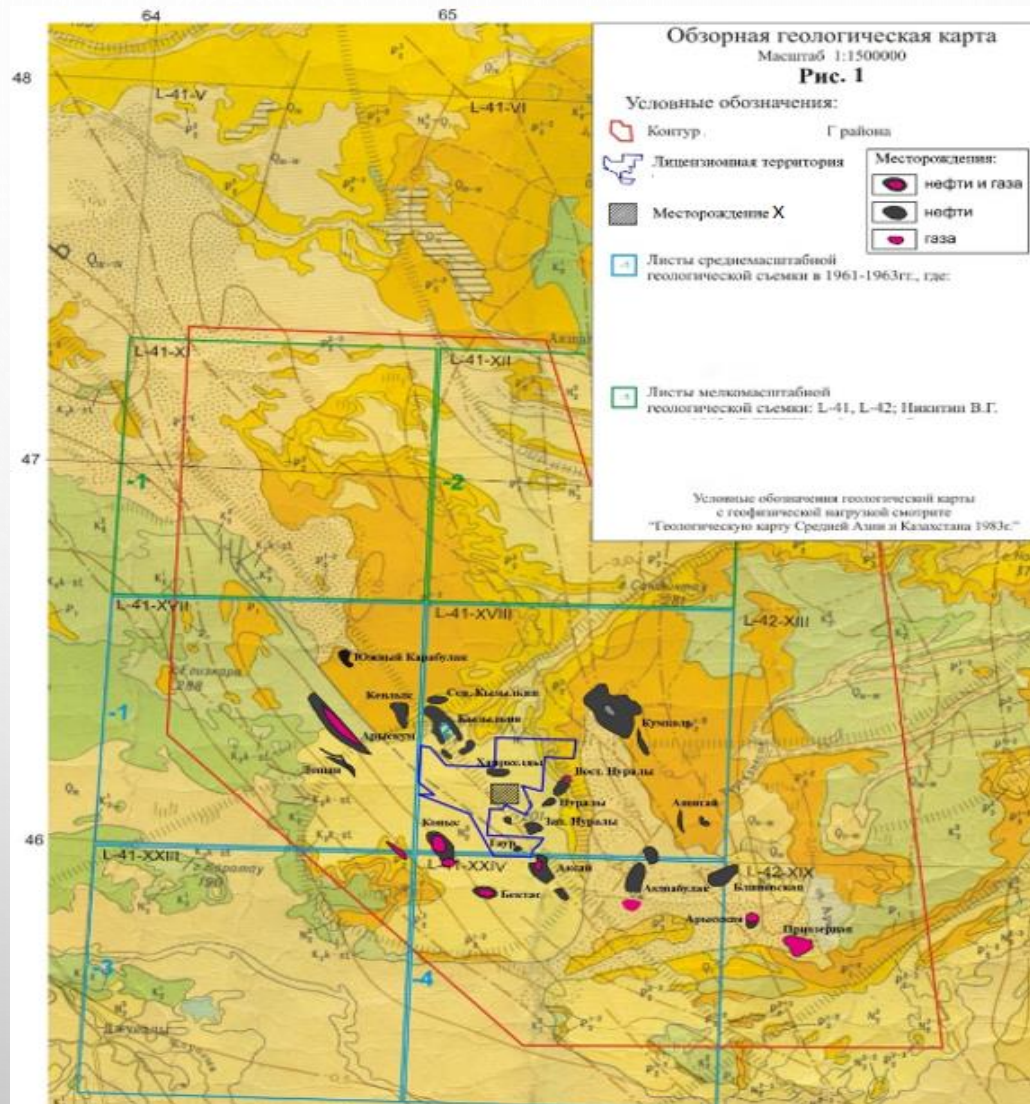
	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3	F3	F4
E1.1	1	2	3	4					
E1.2	1	2	3						
E2			4	4	5				
E3.1		12	12	12	12	12			
E3.2			6	6	6		8	9	10
E3.3					7	7			11

Field X

Administratively, Field X is located in the Kyzylorda Oblast of the Republic of Kazakhstan.

Geographically, the field is located in the southwestern part of the Torgai trough.

Based on the regional nomenclature of productive horizons at field X, oil deposits were identified in the Lower Neocomian deposits K1nc1 (horizons: M-II-1; M-II-2; M-II-3) and in the upper Jurassic J3 (horizons U-0-1 , U-0-2, U-0-3, U-0-4, U-I).



In 2019, the report « Oil reserve Re-estimation of X field as of 02.01.2019» was prepared.

Original Oil in Place and recoverable oil reserves approved according to the classification of the State Reserves Committee of the Republic of Kazakhstan in the following quantities and categories:

- B - 929 thousand tons of geological, including recoverable - 346 thousand tons,
- C₁ - 2064 thousand tons of geological, including recoverable - 741 thousand tons,
- C₂ - 316 thousand tons of geological, including 92 thousand tons of recoverable ones.

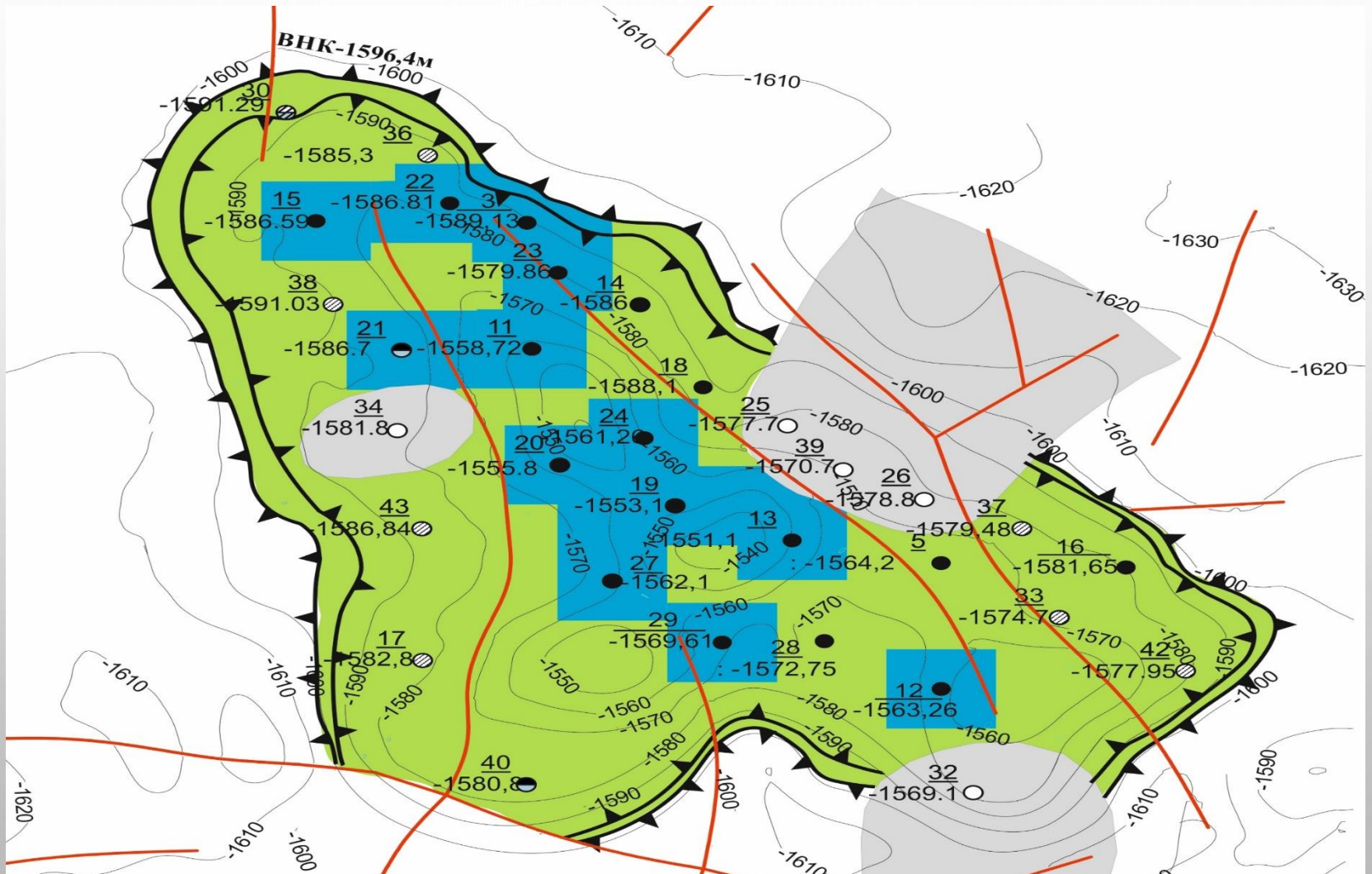
For field X, as of 02.01.2019, the Remaining Recoverable Oil in Place calculated according to the classification of the State Reserves Committee of the Republic of Kazakhstan are as follows:

B+ C₁ categories - 2678 thousand tons,

C₂ category - 92 thousand tons.

In terms of recoverable oil reserves, according to the classification of the State Reserves Committee of the Republic of Kazakhstan, field X belongs to the category of small fields with reserves of up to 3 million tons.

Top structure map productive horizon M-II-1 (object I development)



Top structure map productive horizon U-0-3 (object II development)



Field X exploration stages and their classification according to UNFC - 2009

Exploration stage

Axis E. Activities were carried out as per Technical Design for the implementation of 3D seismic surveys in 3D modification (90 km²) and the Exploration Project for areas increment . Results of carried out activities did not allow to determine the economic feasibility of oil production due to lack of information.

*Therefore, the economic feasibility of oil production and marketing at the search stage can be classified according to UNFC-2009 in the **E3.2** subcategory.*

Axis F. After the implementation of the “Exploration Project”, *the field was not explored and additional studies were required to justify commercial production and time therefore, according to UNFC-2009, the validity of the project (axis F) corresponds to sub-category **F2.2**.*

Axis G. The additional volume of 3D seismic work in 2011 and drilling the wells according to “ Exploration Project” led to the discovery filed X. Operational reserves estimation performed without a feasibility study for the oil recovery coefficient *allows to classify the geological knowledge to the **G3** category according to UNFC- 2009, since recoverable quantities are rated with a low degree of confidence.*

The results of the exploration stage can be classified according to UNFC as **E3.2; F2.2; G3**

Trial phase

Axis E. The results of the trial operation of the field X suggested a cost-effective production and sale of oil in the foreseeable future.

*The economic feasibility of oil production and marketing for the trial operation project can be classified according to UNFC-2009 in category **E.2**.*

Axis F. The tasks set in the trial operation project are implemented. The necessary amount of information was obtained, which made it possible to carry out the first calculation of reserves with a feasibility study of oil recovery factors (FS ORF). Calculations of the ORF feasibility study confirmed the need to draw up a technological scheme for the development and implementation of the project in the foreseeable future.

*Based on the foregoing, according to the UNFC-2009 classification, the feasibility of the project (axis F) corresponds to subcategory **F2.1**.*

Axis G. The purpose of the trial operation is to clarify the initial geological and field data to calculate reserves and draw up a technological development scheme. The reserves calculation report based on the results of the trial operation became the basis for drawing up the technological scheme for the development of the X field. The results of the implementation of the trial operation project allow us to attribute the geological exploration and confidence in the UNFC-2009 estimates to the **G2** category.

The results of the trial phase can be classified by UNFC as **E2; F2.1; G2**

Field development

Axis E. Commercial oil production at field X is carried out on the basis of two projects “technological development scheme ...” and project a “analysis of development of field X”. As of January 2, 2019, the *economic feasibility of oil production and marketing during industrial development can be classified according to UNFC-2009 into categories and subcategories **E1.1 and E2.***

Axis F. As of January 2, 2019, most of the field’s area has been drilled with production wells and oil is being commercialized in accordance with the approved project documents. Based on the foregoing, *the validity of the UNFC-2009 classification project should be categorized as **F1.1, F1.2 and F1.3.***

Axis G. The commencement of industrial development of the field made it possible to conduct additional research on newly drilled wells and to deepen the knowledge of oil deposits. In 2019, the oil reserves of field X were recalculated as of January 2, 2019, where reserves and categories were refined.

Oil reserves of field x as of the state of knowledge as of 02.01.2019 amounted to the following categories:

B + C₁ - 2993 thousand tons geological, including recoverable - 1087 thousand tons;

C₂ - 316 thousand tons geological, including recoverable - 92 thousand tons.

*As of January 2, 2019, at x field, geological exploration and confidence in the estimates of UNFS-2009 can be classified as **G1 + 2.***

Oil reserves as of 02.01.2019, field X along three main axes (criteria) E, F, G according to UNFC-2009 can be classified as **E1.1, E2, F1.1, F1.2, F1.3, G1 + 2.** Oil reserves of industrial categories B + C₁ correspond to categories and subcategories **E1.1, F1.1, F1.2, G1** according to UNFC-2009.

Oil reserves of the estimated categories c2 correspond to the categories and subcategories **E2, F1.3, G2** according to UNFC-2009.

Oil field X reserves by categories and subcategories of UNFC-2009

Oil reserves of commercial categories B + C₁ correspond to categories and subcategories **E1.1, F1.1, F1.2** according to UNFC-2009.

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3	F3	F4
E1.1	1	2							
E1.2									
E2			4						
E3.1									
E3.2									
E3.3									

Oil reserves of the estimated category C₂ correspond to the categories and subcategories **E2, F1.3** according to UNFC-2009.

Oil reserves

Class	Sub-class	Code	RK Categories
Commercial Projects	On Production	1	B, C1
	Approved for Development		
	Justified for Development		
Potentially Commercial Projects	Development Pending	4	C2
	Development On Hold		

Quantification of UNFC resources

Field X development is considered as one project.

Cumulative oil production:

	RK	UNFC_2009	thsd. Ton
Recoverable	B	E1.1, F2.2, G1	346
Recoverable	C1	E1.2, F2.2, G1	741
Recoverable	C2	E2, F2.2, G2	92
Total Recoverable	B+C1+C2	E1.1, E1.2, E2, F2.2, G1+G2	1179
non-recoverable	B*+C1*+C2*	E3.3, F4, G1+G2	2130

Cumulative associated petroleum gas:

$$GF = 109 \text{ m}^3 / \text{t}$$

	RK	UNFC_2009	mln. m ³
Recoverable	B	E1.1, F2.2, G1	38
Recoverable	C1	E1.2, F2.2, G1	81
Recoverable	C2	E2, F2.2, G2	10
Total Recoverable	B+C1+C2	E1.1, E1.2, E2, F2.2, G1+G2	129
non-recoverable	B*+C1*+C2*	E3.3, F4, G1+G2	232